the cleaning solution in place, the freshly cleaned surface is maintained during spotwelding. After the spotwelding is complete, the drop of cleaning solution is removed with a pipette and the sample flushed with distilled water several times.

Samples treated in this way produced acceptable spotwelds at much lower power than uncleaned samples. The task of attaching 0.5-mm-diam W-Re thermocouple wires to Mo, essentially impossible prior to cleaning, was accomplished with only 10 W s ($\sim$1.5-ms pulse) using our technique. Similar improvement was found for spotwelding tantalum wire and foil to Mo.

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Passivated uranium as an electron-spin analyzing target

D. P. Pappas and H. Hopster

Institute for Surface and Interface Science and Department of Physics, University of California at Irvine, Irvine, California 92717

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A passivated uranium surface has been tested as an electron-spin analyzing target in a retarding potential Mott detector. The effective Sherman function and yield were measured for electron energies of 15–34 keV at energy-loss acceptance windows of 500 and 1000 eV. The figure of merit was found to be $\approx 1\times10^{-5}$. The uranium target had a higher Sherman function than either gold or thorium at 20-keV and 500-eV energy loss. The passivated surface is also extremely stable, thus proving to be an acceptable target for electron-spin analysis.

Electron-spin polarization detectors which operate at much lower voltages than the traditional Mott detectors have become increasingly popular recently.[1–3] In this note we report on the performance of a medium-energy, retarding potential Mott detector with a passivated uranium surface as the analyzing target.

The detector is based on the Rice design,[4] which utilizes a high-Z scattering target held at $V_s = 20$–30 keV. The left-right electron scattering asymmetry is related to the spin polarization normal to the scattering plane[5,6] by

$$P = \frac{1}{S_{\text{eff}}}\frac{I_L - I_R}{I_L + I_R}.$$

Here, the Sherman function S represents the relativistic, spin-orbit correction to the elastic cross section. The electron detectors are held at a lower voltage V_w so that the electrons are decelerated (i.e., retarded) before they are detected. Therefore, only electrons which have lost less than V_w in energy will be counted. This eliminates most multiple *e*$^-$*-nucleus* scattering events, since they are likely to have lost more energy than single scattering events. The larger V_w (i.e., energy-loss window), the lower the effective S.

The widely accepted criterion used to evaluate the performance of an electron-spin polarimeter is the figure of merit (FM)[7]:

$$\text{FM} = S_{\text{eff}}^2 (I/I_0).$$

The FM is purely based on counting statistics, reflecting the relative weight of S_{eff} and the backscattered yield I/I_0 when calculating the statistical uncertainty of a measured polarization. The sensitivity of the detector to systematic errors from beam deflections is not included in the FM. In general, increasing the Sherman function will reduce the effect of beam deflections on a measured polarization.

Because S_{eff} increases with increasing nuclear charge of the target, uranium ($Z = 92$) was chosen as a potential electron-spin analyzer. Pure uranium, however, is chemically reactive, oxidizing within a few minutes of exposure to the atmosphere. This renders natural uranium unsuitable as a spin analyzer by reducing the yield and creating an unstable surface. Passivation of the uranium surface was achieved by following the prescription given by Allen and Holmes.[8] A 0.178-mm-thick, 99.99% pure uranium foil was used,[9] and the black oxide film was removed by immersion in dilute nitric acid until the foil attained the characteristic silvery white appearance of the pure metal. The foil was immediately electropolished in 1:1:1 H_2SO_4:H_3PO_4:H_2O at 0.2 A/cm^2, rinsed with de-ionized water and ethanol, and promptly placed into a UHV chamber which was then pumped down to $\approx 10^{-10}$ Torr. The surface was cleaned by neon bombardment for 4 h from a sputter gun operating at 2 keV and a beam density of 20 μA/cm^2, and then passivated by substituting nitrogen for neon and sputtering for $\approx$1 h. The foil was removed from the chamber, mounted inside of the spin detector, and the system was again pumped down.

In order to measure S_{eff}, a spin-polarized electron beam was obtained by photoemission from a negative electron affinity GaAs(100) cathode using circularly polarized light. In order to account for any spin precession in the electron-transfer optics, all three components of the spin polarization

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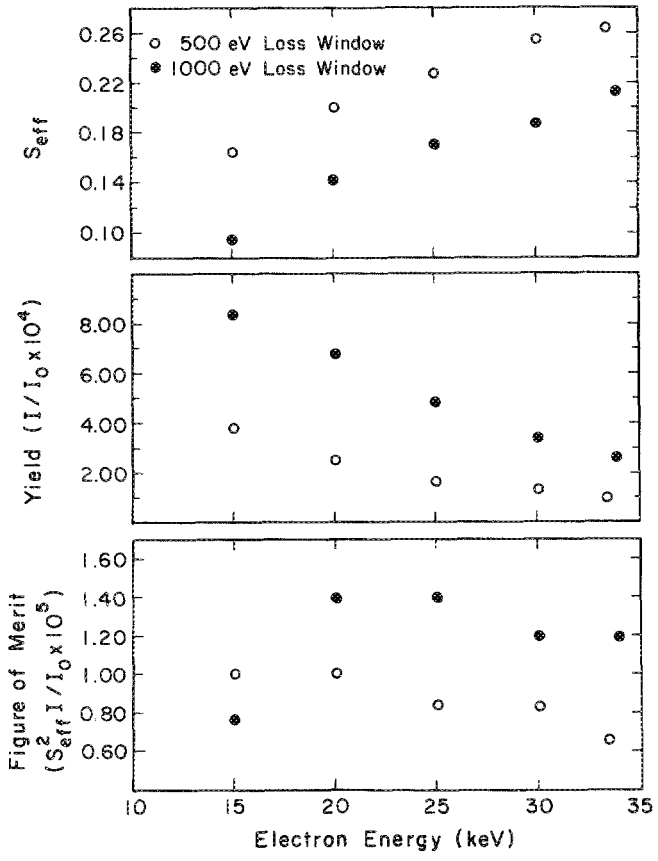

FIG. 1. The effective Sherman function (top panel), the detector yield (center), and the figure of merit (bottom) for electron scattering energies of 15–34 keV, and energy-loss acceptance windows of 500 and 1000 eV.

were measured. In practice, this is achieved by using two identical spin detectors which are mounted at 90° to each other. The two transverse components of spin are measured by the detector which is in the beam line, and the remaining longitudinal component can be measured by electrostatically deflecting the electrons into the other detector.

The passivated uranium surface was then tested as a spin analyzer for $V_s = 15$–34 keV at two different energy-loss acceptance windows. In Fig. 1 it can be seen that $S_{\rm eff}$ increases with increasing V_s, and decreases for larger V_w, as expected. Conversely, the yield decreases with increasing V_s, and increases for larger V_w. The result of these competing effects is reflected by the FM. The FM can be maximized by sacrificing in the Sherman function while gaining in yield; however, the detector can also be used with a high $S_{\rm eff}$ (e.g., to minimize beam-deflection effects), with the FM still $\approx 1\times10^{-5}$.

At scattering energies of 30 keV and $V_w = 500$ eV, we found $S_{\rm eff} \approx 0.20$. For comparison, measurements taken by McClelland, Scheinfein, and Pierce[10] from gold and thorium give 0.14 and 0.17, respectively.[11] The increase of $S_{\rm eff}$ with Z is observed, but the absolute magnitudes should not be compared too carefully, since neither experiment was calibrated to an absolute scale. This is due to the assumption that the beam polarization was 28%; thus $S_{\rm eff}$ is only known within $\approx 10\%$. To determine $S_{\rm eff}$ to within 2%, it would be necessary to do a triple scattering experiment.[12]

In conclusion, we note that the uranium surface remains stable even after prolonged exposure to the atmosphere, as illustrated in Ref. 8. In addition, we have found that the Sherman function and yield, and therefore the figure of merit, remain unchanged after exposure to the atmosphere for at least 1 day, which indicates that in UHV conditions the usable lifetime of the uranium surface as a spin analyzer should be many years. The use of a passivated uranium surface in a medium-energy retarding potential Mott detector is therefore desirable due to the long lifetime coupled with the high figure of merit and effective Sherman function.

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